NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL NOTE

No. 1110

TWO-DIMENSIONAL WIND-TUNNEL INVESTIGATION OF AN APPROXIMATELY 14-PERCENT-THICK NACA 66-SERIES-TYPE AIRFOIL SECTION WITH A DOUBLE SLOTTED FLAP

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Langley Field, Va.

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SUMMARY

A two-dimensional wind-tunnel investigation was made for the purpose of developing a suitable double slotted flap on an approximately 14-percent-thick modified NACA 66-series-type airfoil section. Section aerodynamic characteristics of the airfoil with various double-slotted-flap arrangements are presented.

A maximum section lift coefficient of 3.0 was obtained for a 55° deflection of a flap arrangement employing a 0.0854-airfoil-chord vane (vane 4). The lift coefficients obtained for flap configurations with vane 4 generally were higher than those obtained with the other vanes tested and were less sensitive to changes in vane position and deflection. Standard airfoil leading-edge roughness caused approximately the same decrement in maximum section lift coefficient for the airfoil with the flap deflected 50° as for the airfoil with the flap retracted. Different values of the maximum section lift coefficient were obtained at high flap deflections when the angle of attack at which the test was begun was not sufficiently low to prevent initial air-flow separation.

INTRODUCTION

Tests were made in the Langley two-dimensional low-turbulence tunnels of an airfoil section equipped with a double slotted flap designed for application to a fighter-type airplane. Preliminary design of the airplane indicated that a maximum section lift coefficient of approximately 3.00 was necessary if the airplane were to have the specified landing and take-off characteristics. The purpose of this investigation was to develop a suitable double-slotted-flap configuration for use on this airplane.

The tests were made of a 24-inch-chord model of an intermediate airfoil section formed by a straight-line fairing between a modified NACA 66(215)-214 root section and a modified NACA $65_{(112)}$-213 tip section. The investigation included the determination of the aerodynamic characteristics of the plain airfoil section and of a considerable number of double-slotted-flap arrangements. Five different vanes were employed in conjunction with the double-slotted-flap tests. The position and deflection of the vanes relative to the flap and of the flap and vane configurations relative to the airfoil were varied in an effort to obtain a high value of the maximum section lift coefficient. The results of this investigation indicate that a maximum section lift coefficient of 3.00 can be obtained with the use of a suitable double-slotted-flap arrangement.

COEFFICIENTS AND SYMBOLS

c_l	airfoil section lift coefficient
$c_{l_{max}}$	maximum airfoil section lift coefficient
c_d	airfoil section drag coefficient
$c_{m_{c/4}}$	airfoil section pitching-moment coefficient at quarter chord
α_o	airfoil section angle of attack
δ	angular flap deflection
c	airfoil chord length
q	free-stream dynamic pressure

MODEL

The airfoil tested was an intermediate profile formed by a straight-line fairing between a modified NACA 66(215)-214 root section and a modified NACA $65_{(112)}$-213 tip section. Each of these airfoil sections had been modified by fairing out the cusp near the trailing edge of the upper surface with a straight line through the trailing edge and tangent to the original airfoil contour. The lower surface had then been modified so that the airfoil mean line was the same as that of the original section. The 24-inch-chord model of the intermediate section tested was made of wood. The surfaces were painted and then sanded with No. 400 carborundum paper to produce an aerodynamically smooth finish.

The investigation was partly complete when it was found that the model did not fit the true airfoil contour calculated from the straight-line fairing. The model was then refaired to conform with the calculated profile. A drawing showing the departure of the original model from the calculated true airfoil contour is given in figure 1. The calculated ordinates of the airfoil section are given in table I.

The flap had a chord of 0.23c and was of cast aluminum polished to a smooth finish. The method of attaching the flap to the airfoil was such that various deflections could be obtained with any one of several pivot points. The flap ordinates and a drawing of the flap are presented in table II.

Sketches of the five vanes tested, which were also of cast aluminum polished to a smooth finish, are given in figure 2. The maximum projected lengths of vanes 1, 3, 4, 5, and 6 were 0.0646c, 0.0646c, 0.0854c, 0.0771c, and 0.0834c, respectively. The method of attaching the vanes to the flap allowed considerable variation in the position and deflection of the vanes relative to the flap. The movement of the vane position was restricted, however, by the necessity of having the double slotted flap retract into the wing without interfering with the wing structure, which had already been designed. It was also necessary to keep the vane position fixed with respect to the flap for all deflections of any given flap-vane configuration. The ordinates of the five vanes tested are given in tables III to VII.

TESTS

This investigation was made in the Langley two-dimensional low-turbulence tunnel (designated LTT) and the Langley two-dimensional low-turbulence pressure tunnel (designated TDT). A brief description of these tunnels and the methods of obtaining the data are given in reference 1. The following formulas derived from reference 1 were used to correct the tunnel data to free-air conditions.

$$c_l = 0.9760c_l'$$

$$c_d = 0.9910c_d'$$

$$q = 1.0090q'$$

$$\alpha_o = 1.015\alpha_o'$$

where the primed quantities represent the values measured in the tunnels.

Lift, drag, and pitching-moment data were obtained for the airfoil with flap retracted. The gaps between the flap and airfoil were sealed but not faired into the airfoil contour. The data were obtained at Reynolds numbers of approximately 2.3×10^6, 6×10^6, 8×10^6, and 9×10^6 with the model both in the original condition and after it had been refaired. The predicted landing Reynolds number for the airplane was 8×10^6. Lift and drag data were also obtained with standard roughness (reference 1) applied to the leading edge of the model at a Reynolds number of 6×10^6.

The problem of determining a suitable flap-vane combination to give the desired lift coefficient of approximately 3.00 involved a considerable number of tests of the model with different vanes and combinations of vane and flap position. Three vanes were originally designed for tests with the flap, but the data obtained with vanes 1 and 3 indicated that tests of vane 2 would be of little value. When the desired maximum section lift coefficient could not be obtained with either vanes 1 or 3, three new vanes were developed.

In order to expedite the required changes in the model, most of the development tests were conducted in the LTT. The Reynolds number at which these tests were performed was approximately 2.3×10^6, the maximum obtainable in the LTT with a 24-inch-chord model. Observations of the air flow through some of the flap-vane combinations were made by tuft surveys. After several acceptable flap and vane combinations had been determined from tests in the LTT, the model was transferred to the TDT for lift tests at Reynolds numbers of 6, 8, and 9×10^6. The variation of the section pitching-moment coefficient with section lift coefficient was also determined in the TDT for a few flap combinations involving vanes 3 and 4.

The flap design parameters varied during the tests included the position and angle of the vane relative to the flap, the flap deflection, and the position of the vane and flap configuration relative to the airfoil. Each combination of vane position and angle relative to the flap has been given a configuration number, the numbers beginning with one for each of the five different vanes. The pertinent dimensions describing the various flap and vane configurations are given in table VIII.

Because of the construction features of the airplane, it was required that a single pivot point be used for all flap deflections, and the original intention was that pivot point A (fig. 3) be used exclusively. In the attempt to increase the maximum lift coefficient, various positions of flap-vane configurations with respect to the airfoil were tested. Different pivot points were therefore required to retract the flap into the airfoil. A drawing showing the location of the various pivot points relative to the airfoil is presented in figure 3. The flap deflections investigated varied, in general, from 40° to 55°.

Drawings showing the various flap-vane configurations tested and their positions relative to the airfoil are so arranged that the drawings of a particular set of flap positions and configurations precede the experimental curves obtained with those combinations.

RESULTS AND DISCUSSION

Flap Retracted

Lift and drag characteristics are given for the plain airfoil in the original condition in figure 4 and for the airfoil after it had been refaired according to the calculated airfoil ordinates in figure 5. Refairing the model resulted in an increase in the maximum section lift coefficient of approximately 0.04 at the landing Reynolds number. In both the original and refaired conditions an increase in maximum lift was observed as the Reynolds number was varied from 2.3×10^6 to 6×10^6. As the Reynolds number was further increased to 9×10^6, little change in the maximum section lift coefficient was noted.

The minimum section drag coefficient at a Reynolds number of 9×10^6 was approximately 0.0035 for the model in both conditions (figs. 4 and 5). Application of standard roughness to the airfoil leading edge caused an increase in the values of c_d similar to that found for the NACA 66-series airfoils of comparable thickness (reference 1).

Flap Deflected

Lift and pitching-moment characteristics of the airfoil with various double-slotted-flap combinations and drawings of the combinations tested are presented in figures 6 to 19.

Comparison of vanes.- Lift data for the airfoil-flap combination employing vane 1 at flap deflections from 0° to 55° are presented in figure 7(a) at a Reynolds number of 2.3×10^6. The effect on the lift characteristics of increasing the Reynolds number from 2.3×10^6 to 9×10^6 is shown in figure 7(b) for the 50° flap deflection. A slight decrease in section lift coefficient along the linear portion of these curves occurs with increasing Reynolds number, but the maximum section lift coefficient does not vary appreciably with an increase in Reynolds number from 6×10^6 to 9×10^6. The value of $c_{l_{max}}$ obtained at a Reynolds number of 8×10^6 for a 50° flap deflection was 2.76.

Because the maximum section lift coefficient obtained with the use of vane 1 was not high enough to meet the requirements for the proposed airplane, lift tests were made of two flap configurations using vane 3 at a Reynolds number of 2.2×10^6 (fig. 9(a)). The highest value of $c_{l_{max}}$ was obtained with configuration 2 at a deflection of 50°. For this flap combination the effect on the lift characteristics of increasing the Reynolds number from 2.2×10^6 to 9×10^6 (fig. 9(b)) is similar to that observed from tests of vane 1. Lift tests were also made at a Reynolds number of 8×10^6 when configuration 2 was deflected 30° and 40° as well as 50° (fig. 9(c)). This range of flap positions includes the deflections which may be used for take-off and landing. Section pitching-moment characteristics at a Reynolds number of 8×10^6 are presented in figure 10 for flap deflections ranging from 0° to 50° in 10° increments.

An examination of the double-slotted-flap arrangements tested with vanes 1 and 3 (figs. 6 and 8) seems to indicate that the desired value of $c_{l_{max}}$ could not be obtained because the small size and profiles of vanes 1 and 3 prevented the attainment of proper air-flow conditions through the flap configurations. For this reason extensive development tests were not made with either vane 1 or vane 3, and tests of vane 2, which was also small, were omitted entirely. Three larger vanes were then designed. (See fig. 2.)

Lift data obtained at a Reynolds number of 2.3×10^6 for double-slotted-flap arrangements with vanes 4, 5, and 6 are presented in figures 12 and 14. These figures show that the highest maximum section lift coefficient was attained with a flap arrangement employing vane 4. This value of $c_{l_{max}}$ was 2.86 as compared with 2.72 and 2.78 attained with flap arrangements employing vanes 5 and 6.

After the model was refaired according to the calculated ordinates, further flap-vane combinations with vanes 6 and 4 were tested at a Reynolds number of 2.3×10^6. These data are presented in figure 16 for vane 6 and in figures 18(a) and 18(b) for vane 4. A maximum section lift coefficient greater than 2.9 was attained with the use of vane 4; whereas a maximum section lift coefficient of 2.78 was the highest value attained with vane 6. Two of the more promising flap combinations using configuration 7 of vane 4 were then tested at Reynolds numbers of 6×10^6 and 9×10^6, lift data for which are presented in figures 18(c) and 18(d). An increase in the Reynolds number from 2.3×10^6 to 9×10^6 resulted in an increase in maximum section lift coefficient to 3.0 for configuration 7 deflected 55° about pivot point G. Pitching-moment characteristics of the airfoil with this flap arrangement and with configuration 7 deflected 50° about pivot point C are presented in figure 19 at a Reynolds number of 6×10^6.

In addition to the value of the maximum section lift coefficient, an important consideration in the selection of a suitable flap-vane combination is the sensitivity of the flap and vane to small changes in position and deflection such as might occur as a result of manufacturing inaccuracies. At a Reynolds number of 2.3×10^6, maximum section lift coefficients between 2.8 and 3.0 were obtained with several of the flap combinations employing vane 4 (fig. 18(a) and 18(b)). These lift coefficients are not only higher than those obtained with other vanes but seem to vary less with changes in vane position and deflection.

Effect of initial angle of attack.- For the wind-tunnel investigation a constant flap deflection was maintained while the section angle of attack was increased from a negative value to the positive stall. At large flap deflections it was found during tests of vane 1 at a Reynolds number of 2.3×10^6 that the air flow through the double slotted flap at the initial angle of attack was partly or completely separated. If the section angle of attack at which the test was begun was not sufficiently low to prevent initial separation the air flow through the flap did not recover throughout the entire range of angle of attack. Results of lift tests which were started at various angles of attack are presented in figure 20. These data show that with a flap deflection of 50° a decrement of maximum section lift coefficient of 0.30 occurred when the initial angle of attack was increased from -12° to -4°. A similar though less pronounced trend may be seen in the results presented for a 40° flap deflection. This anomaly has also been noted in the TDT at higher Reynolds numbers of approximately 6×10^6.

Because the data obtained during tests of vane 1 seem to indicate that the initial flow pattern through the double slotted flap becomes less dependent on the starting angle of attack as the flap deflection is decreased, and because similar irregularities in the air flow have not been observed at low flap deflections during other double-slotted-flap investigations, it is thought that only one flow pattern, independent of starting angle of attack, could be established at the low flap deflections. Under actual flight landing conditions it appears more likely that the higher rather than the lower lift coefficients would be obtained at high flap deflections, because a good flow pattern probably would be initially established through the flap as it is deflected from the retracted position. The lift tests reported herein were started, therefore, at an angle of attack low enough to insure that the better initial flow conditions be obtained at high flap deflections. An initial section angle of attack of -12° was considered suitable, as tests begun at lower angles showed no increment in the section lift coefficient. If the flap deflection required for take-off is such that two flow patterns may exist, however, these two-dimensional results seem to indicate that the lower lift coefficients would be obtained.

Tuft surveys.- Air-flow conditions observed from tuft surveys indicated that smooth, unstalled flow over the vane and flap and through the gap between the airfoil and vane is essential if high lift coefficients are to be realized. The greatest decrement in $c_{l_{max}}$ seemed to result when the vane stalled. The tuft surveys also showed that the airfoil itself stalled at low positive section angles of attack. This observation seems to indicate that at least part of the difficulty encountered in realizing high maximum section lift coefficients resulted from stalling of the airfoil rather than of the flap or vane.

Effect of leading-edge roughness.- The effect on the maximum section lift coefficient of standard airfoil leading-edge roughness was determined for one of the better flap combinations using vane 4. The data were obtained at a Reynolds number of 6×10^6 and are presented in figure 18(c), together with the data obtained for the same Reynolds number and flap combination with the airfoil leading edge in the smooth condition. The decrement in maximum section lift coefficient caused by standard airfoil leading-edge roughness was approximately the same for the airfoil with the flap deflected 50° (fig. 18(c)) as for the airfoil with the flap retracted (fig. 5).

CONCLUSIONS

The results of a two-dimensional wind-tunnel investigation of an approximately 14-percent-thick modified NACA 66-series-type airfoil section equipped with a double slotted flap indicate the following conclusions:

1. A maximum section lift coefficient of 3.0 was obtained for a 55° deflection of a flap configuration employing a 0.0854-airfoil chord vane (vane 4).

2. The lift coefficients obtained with the use of vane 4 generally were higher than those obtained with the other vanes tested and were less sensitive to changes in vane position and deflection.

3. Standard airfoil-leading-edge roughness caused approximately the same decrement in maximum section lift coefficient for the airfoil with the flap deflected 50° as for the airfoil with the flap retracted.

4. Different values of the maximum section lift coefficient were obtained at high flap deflections if the angle of attack at which the test was begun was not sufficiently low to prevent initial air-flow separation.

Langley Memorial Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Field, Va., April 22, 1946

REFERENCE

1. Abbott, Ira H., von Doenhoff, Albert E., and Stivers, Louis S., Jr.: Summary of Airfoil Data. NACA ACR No. L5C05, 1945.

TABLE I

ORDINATES OF AN AIRFOIL SECTION FORMED BY A STRAIGHT-LINE FAIRING BETWEEN A MODIFIED NACA 66(215)-214 AIRFOIL SECTION AND A MODIFIED NACA $65_{(112)}$-213 AIRFOIL SECTION

[Stations and ordinates given in percent airfoil chord]

Upper Surface		Lower Surface	
Station	Ordinate	Station	Ordinate
0	0	0	0
.171	.733	.171	-.629
.258	.854	.429	-.825
.429	1.058	.688	-1.042
.517	1.154	.863	-1.146
.688	1.300	1.033	-1.250
.863	1.438	1.308	-1.388
1.163	1.638	1.363	-1.413
1.979	2.083	1.558	-1.500
2.396	2.267	1.721	-1.558
3.446	2.704	2.617	-1.871
4.892	3.204	5.142	-2.525
7.392	3.938	7.629	-3.067
9.871	4.575	10.121	-3.504
14.875	5.563	15.133	-4.204
19.896	6.358	20.113	-4.738
24.908	6.950	25.117	-5.133
30.050	7.433	30.079	-5.425
34.863	7.750	35.083	-5.633
39.967	7.942	38.288	-5.763
45.046	8.021	44.946	-5.796
49.983	7.967	49.975	-5.746
54.367	7.763	55.425	-5.646
60.033	7.375	60.025	-5.246
65.054	6.813	64.925	-4.746
70.096	6.021	69.896	-4.050
75.092	5.083	74.883	-3.283
80.079	4.083	79.913	-2.471
90.292	2.025	84.900	-1.742
94.746	1.138	89.992	-1.042
100.000	.067	94.850	-.450
-----	-----	100.000	-.067

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TABLE II

ORDINATES OF THE FLAP TESTED

[Stations and ordinates given in percent airfoil chord]

Upper Surface		Lower Surface	
Station	Ordinate	Station	Ordinate
77.29	0	79.91	-2.47
78.00	1.00	84.90	-1.74
79.00	1.79	89.99	-1.04
80.00	2.27	94.85	-.45
81.00	2.56	100.00	-.07
82.00	2.74		
83.50	2.88		
84.00	2.90		
85.50	2.86		
86.00	2.80		
90.29	2.03		
94.75	1.14		
100.00	.07		
L.E. radius: 1.5 percent chord			

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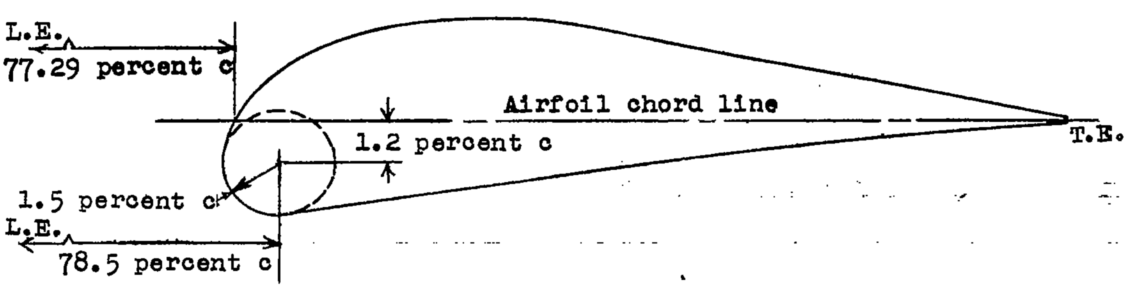

TABLE III

ORDINATES OF VANE 1

[Stations and ordinates given in percent vane chord]

Upper Surface		Lower Surface	
Station	Ordinate	Station	Ordinate
0	14.50	0	14.50
1.61	19.98	1.61	7.42
3.22	23.70	3.22	5.23
6.45	28.70	6.45	2.26
9.68	32.00	9.68	.87
12.89	34.16	12.89	.42
16.12	35.78	16.12	.39
24.19	38.05	24.19	2.48
32.24	38.34	32.24	7.10
40.30	36.42	40.30	10.54
48.38	33.86	48.38	12.18
56.44	30.30	56.44	12.24
64.50	26.19	64.50	11.28
72.60	21.28	72.60	9.68
79.05	16.93	79.05	7.64
88.72	10.16	88.72	4.30
96.75	4.06	96.75	.11
99.19	2.20	99.19	0
100.00	1.60	100.00	----

TABLE IV

ORDINATES OF VANE 3

[Stations and ordinates given in percent vane chord]

Upper Surface		Lower Surface	
Station	Ordinate	Station	Ordinate
0	11.61	0	11.61
1.61	19.67	1.61	5.16
3.22	22.58	3.22	3.22
6.45	26.44	6.45	1.12
9.68	29.35	9.68	.32
12.89	31.81	12.89	0
16.12	33.52	16.12	0
24.19	36.65	24.19	.65
32.24	38.38	32.24	2.26
40.30	38.29	40.30	3.87
48.38	36.29	48.38	6.13
56.44	33.02	56.44	8.39
64.58	28.60	64.58	9.36
72.60	23.70	72.60	9.52
80.65	17.90	80.65	8.07
88.72	11.61	88.72	5.32
96.79	4.51	96.79	1.25
99.00	2.39	99.00	0
100.00	1.60	100.00	----

TABLE V

ORDINATES OF VANE 4

[Stations and ordinates given in percent vane chord]

Upper Surface		Lower Surface	
Station	Ordinate	Station	Ordinate
0	14.25	0	14.25
1.19	19.00	1.19	9.74
2.38	21.14	2.38	7.84
4.75	24.98	4.75	5.46
7.13	26.37	7.13	3.80
11.88	29.50	11.88	1.78
17.82	32.10	17.82	.36
23.75	33.49	23.75	0
29.69	33.99	29.69	.71
35.63	33.62	35.63	2.14
41.57	32.90	41.57	3.56
47.51	31.35	47.51	5.23
53.44	29.22	53.44	7.13
59.38	26.82	59.38	8.91
65.32	23.99	65.32	9.74
71.26	21.11	71.26	9.98
77.20	17.81	77.20	9.50
83.14	14.01	83.14	8.08
89.07	9.98	89.07	5.71
95.01	5.34	95.01	2.38
98.81	2.61	98.81	0
100.00	1.66	100.00	----

TABLE VI

ORDINATES OF VANE 5

[Stations and ordinates given in percent vane chord]

Upper Surface		Lower Surface	
Station	Ordinate	Station	Ordinate
0	8.11	0	8.11
1.35	13.25	1.35	4.19
2.70	15.54	2.70	2.85
5.41	19.00	5.41	1.25
8.11	21.61	8.11	.32
10.81	23.63	10.81	0
13.51	25.35	13.51	.25
20.25	28.70	20.25	1.35
27.01	30.60	27.01	3.11
33.79	31.60	33.79	5.41
40.55	31.70	40.55	7.76
47.29	31.09	47.29	10.13
54.08	29.59	54.08	12.22
60.81	27.34	60.81	13.51
67.59	24.59	67.59	13.78
74.31	21.08	74.31	13.24
81.09	16.88	81.09	11.57
87.81	11.89	87.81	8.52
94.60	6.49	94.60	3.65
98.80	2.70	98.80	0
100.00	1.40	100.00	----

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TABLE VII

ORDINATES OF VANE 6

[Stations and ordinates given in percent airfoil chord]

Upper Surface		Lower Surface	
Station	Ordinate	Station	Ordinate
0	12.50	0	12.50
1.25	18.12	1.25	6.75
2.50	20.74	2.50	5.00
5.00	23.25	5.00	2.85
7.50	25.69	7.50	1.530
10.00	27.70	10.00	.65
12.50	29.32	12.50	.30
18.75	32.25	18.75	.63
25.00	34.20	25.00	1.75
31.25	35.29	31.25	3.15
37.50	35.80	37.50	5.00
43.75	35.61	43.75	7.12
50.00	34.13	50.00	9.00
56.25	31.88	56.25	10.25
62.50	28.75	62.50	10.88
68.75	25.30	68.75	10.75
75.00	21.25	75.00	9.88
81.25	16.93	81.25	8.43
87.50	12.13	87.50	5.92
93.75	7.10	93.75	2.80
99.40	1.88	99.40	0
100.00	1.25	100.00	----

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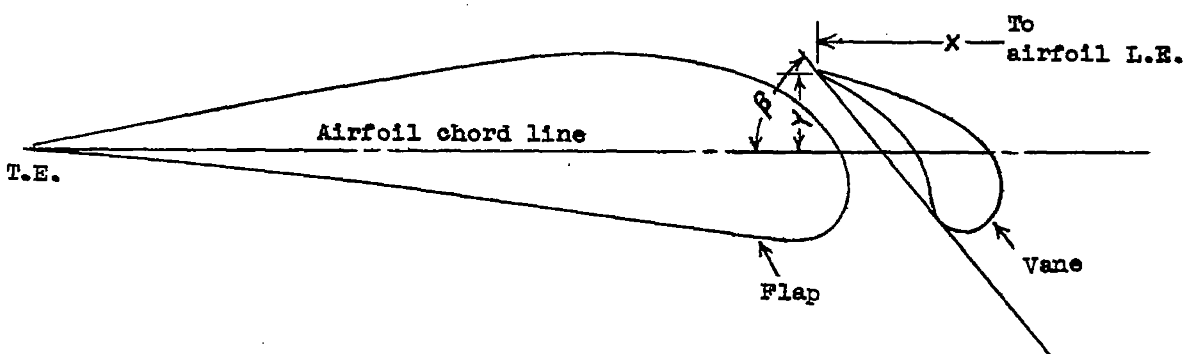
TABLE VIII

DIMENSIONS OF THE VARIOUS FLAP AND VANE CONFIGURATION

Vane	Configu-ration	Vane T.E. position		Angle between vane tangent line and airfoil chord line, β (deg)
		From airfoil L.E., x, (percent c)	Above airfoil chord line, y, (percent c)	
1	1	78.00	2.45	52.5
3	1	78.54	2.04	51.0
3	2	77.71	1.88	48.5
4	1	78.54	2.75	44.0
4	2	78.83	2.79	42.5
4	3	78.08	2.38	44.5
4	4	77.75	1.88	44.5
4	5	76.96	1.54	40.0
4	6	76.88	1.42	40.0
4	7	77.63	2.50	44.25
5	1	77.83	2.17	50.0
6	1	76.83	1.75	39.0
6	2	77.25	1.38	39.0
6	3	76.54	1.83	45.0
6	4	75.75	2.08	44.5
6	5	76.00	1.42	47.0
6	6	77.25	1.58	34.25



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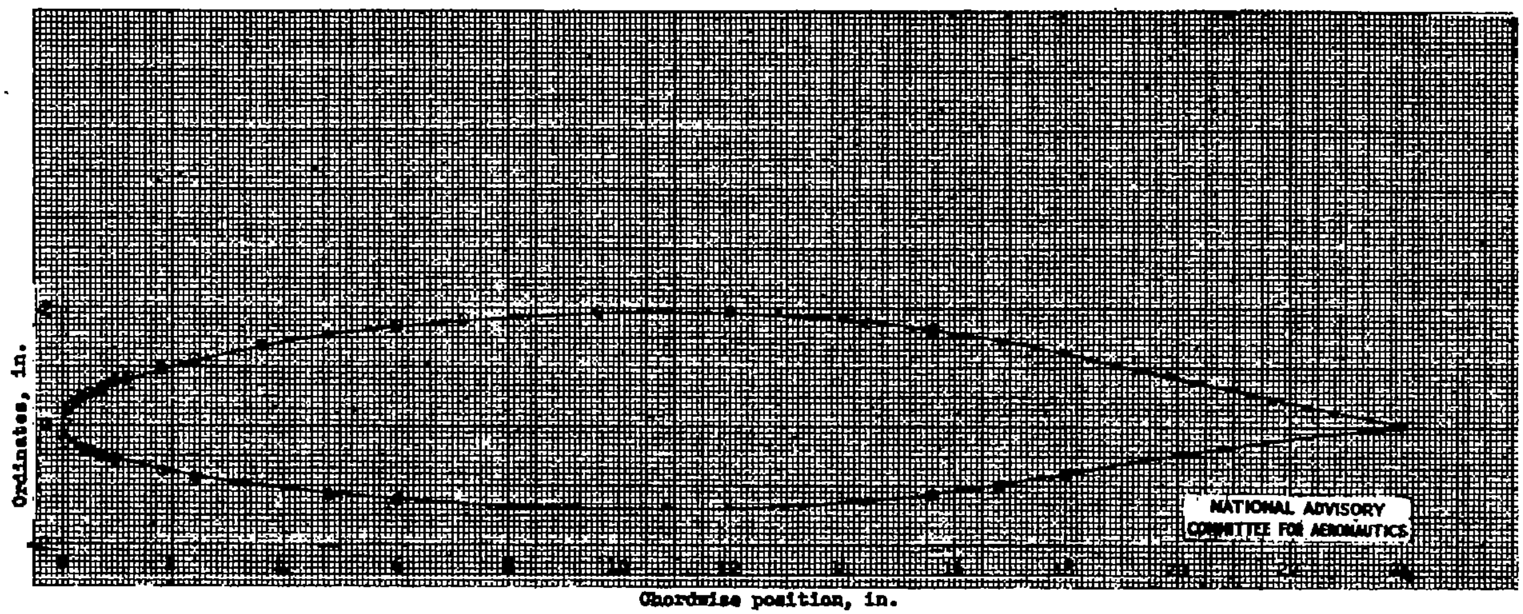

Figure 1.- Airfoil section formed by a straight-line fairing between the modified NACA 66(215)-214 and the modified NACA 65(112)-213 airfoil section. The circled points indicate variations in the contour of the original airfoil model from the true contour.

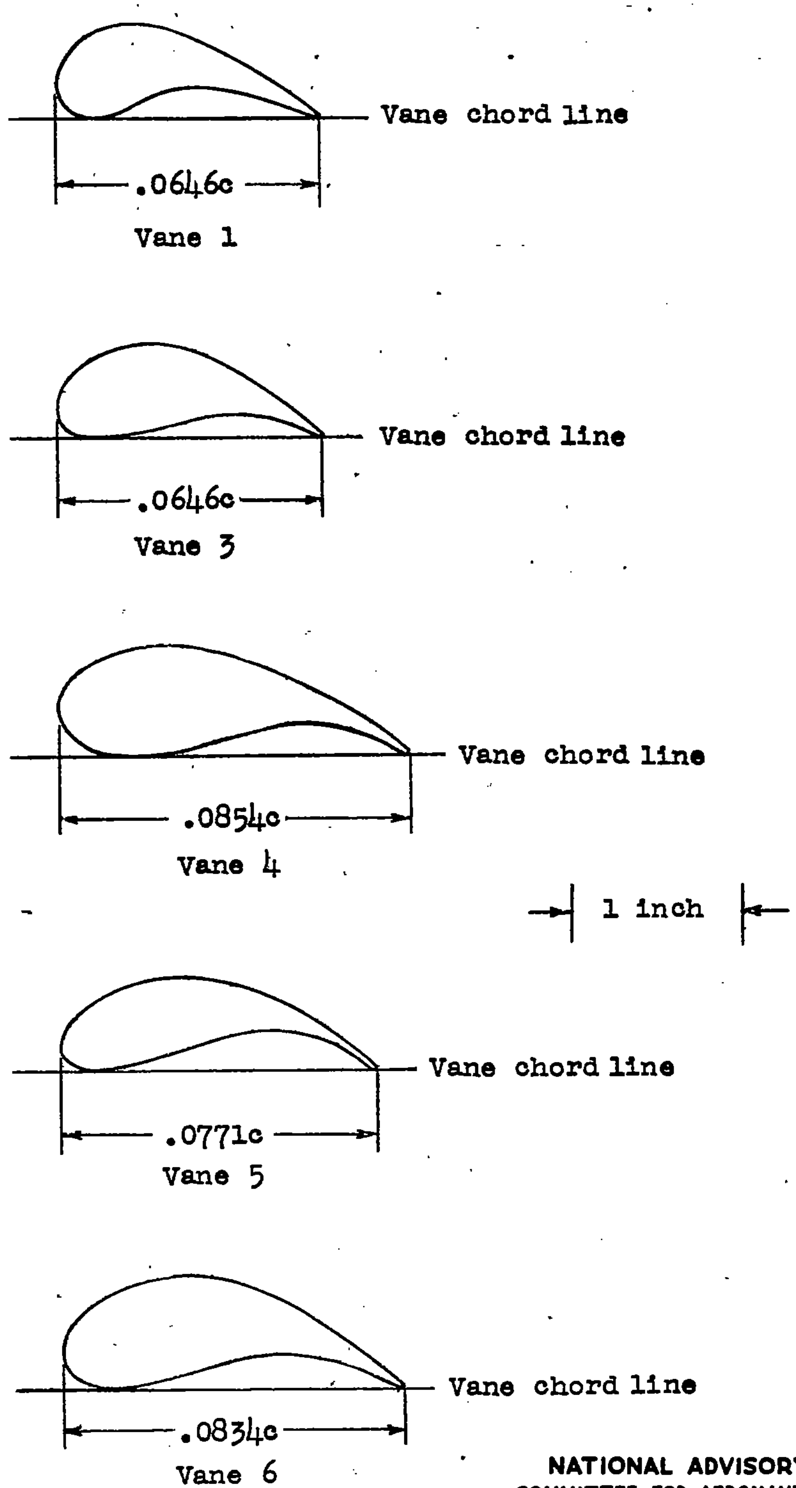

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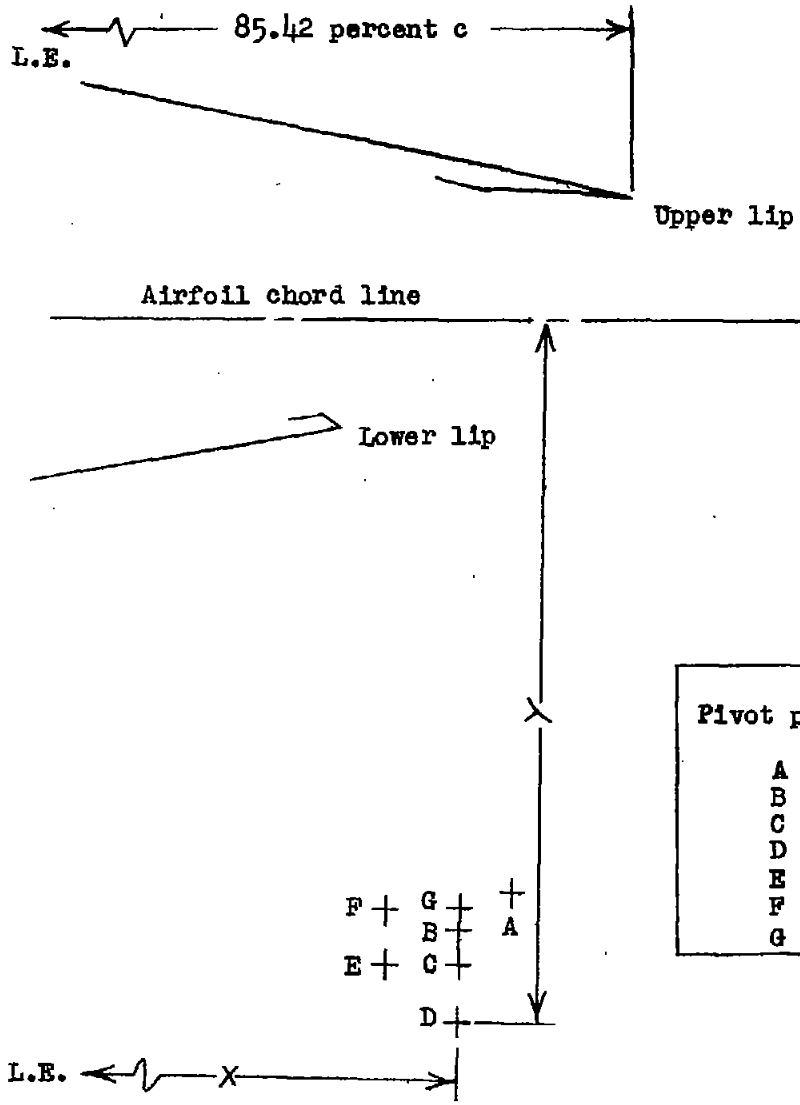
Figure 2.- Sketches of the five vanes used on the 24-inch-chord double slotted flap model.



Pivot point	x (percent c)	y (percent c)
A	82.27	14.67
B	80.83	15.52
C	80.83	16.46
D	80.83	17.96
E	78.83	16.46
F	78.83	14.96
G	80.83	14.96

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Figure 3.- Various pivot points employed for tests of the double slotted flap.

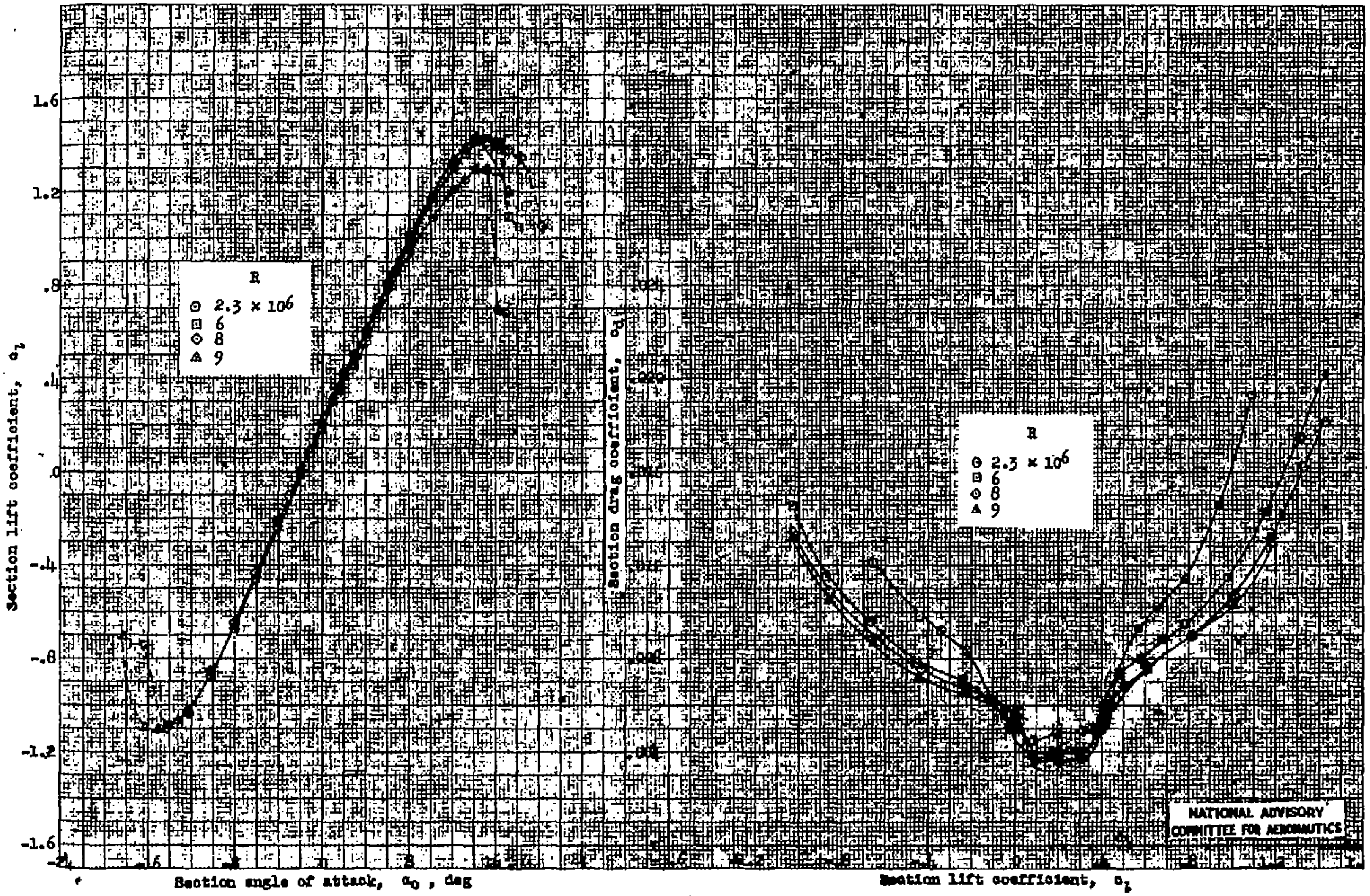

Figure 4.- Lift and drag characteristics of an approximately 14-percent-thick NACA 66-series-type airfoil section equipped with a double slotted flap. Flap retracted and gaps sealed, not faired; original ordinates; test, TDT 724.

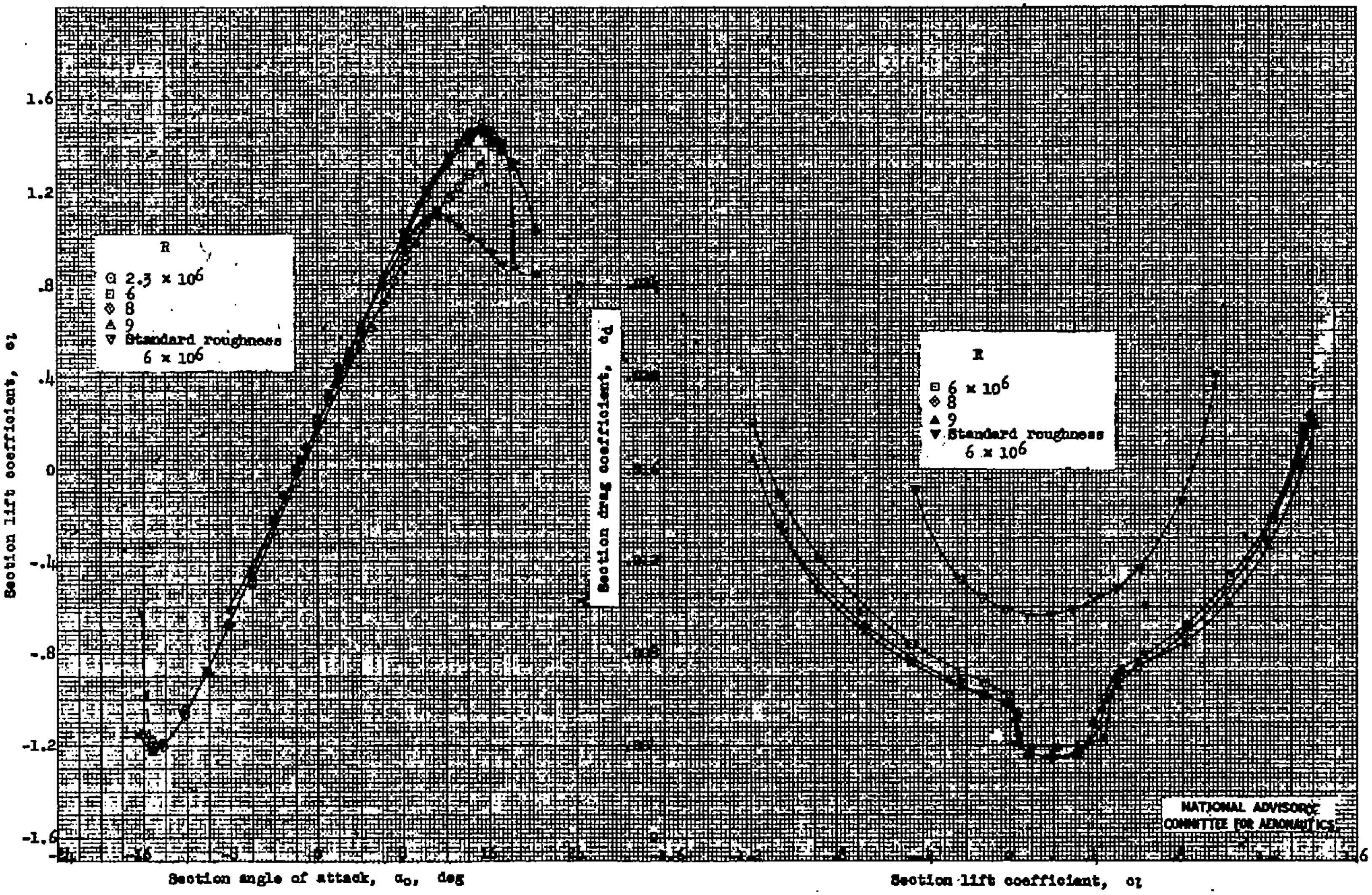

Figure 5.- Lift and drag characteristics of an approximately 14-percent-thick NACA 66-series-type airfoil section equipped with a double slotted flap. Flap retracted and gaps sealed, not faired; calculated ordinates; tests, TDT 740, 732 and LTT 370.

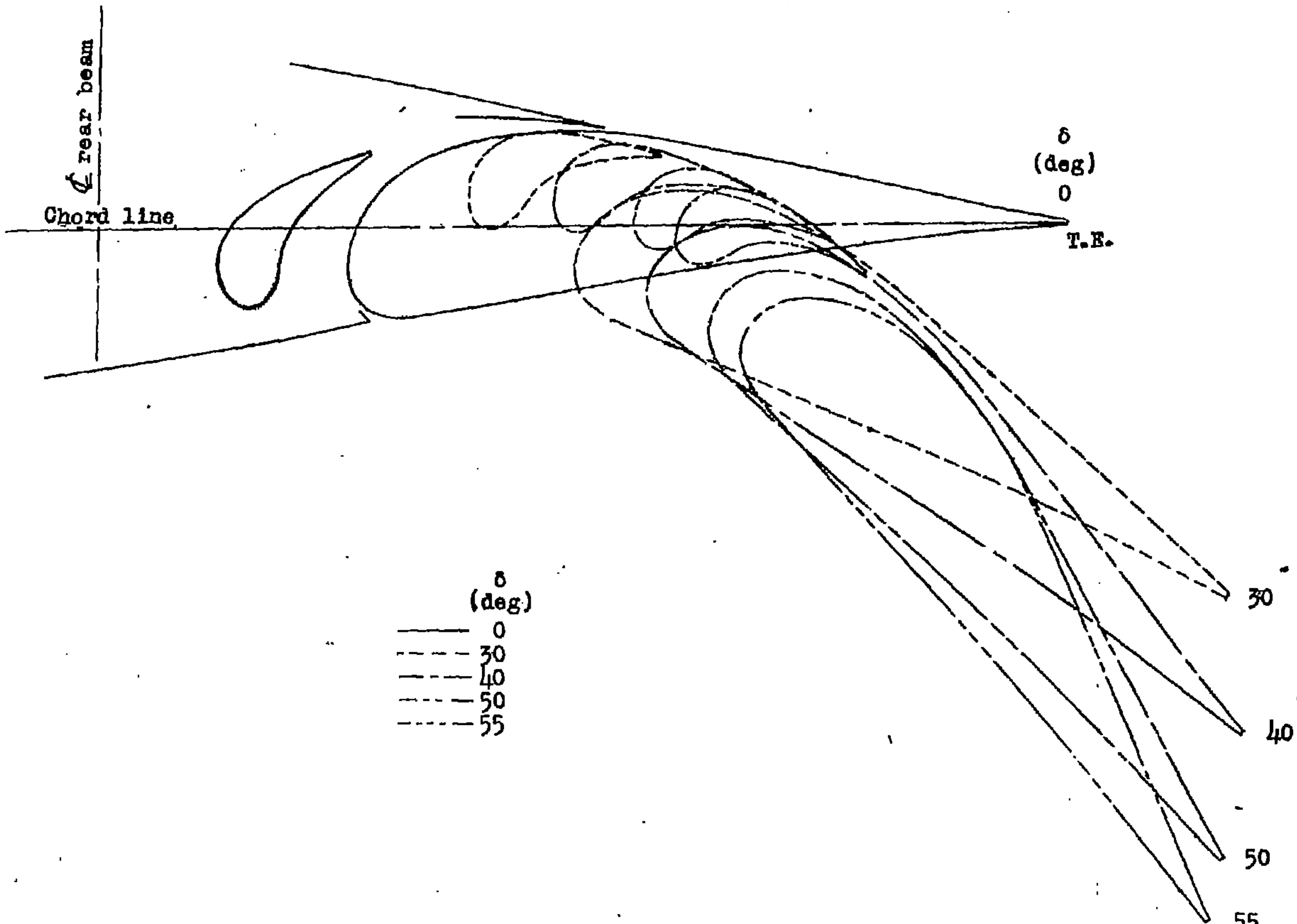

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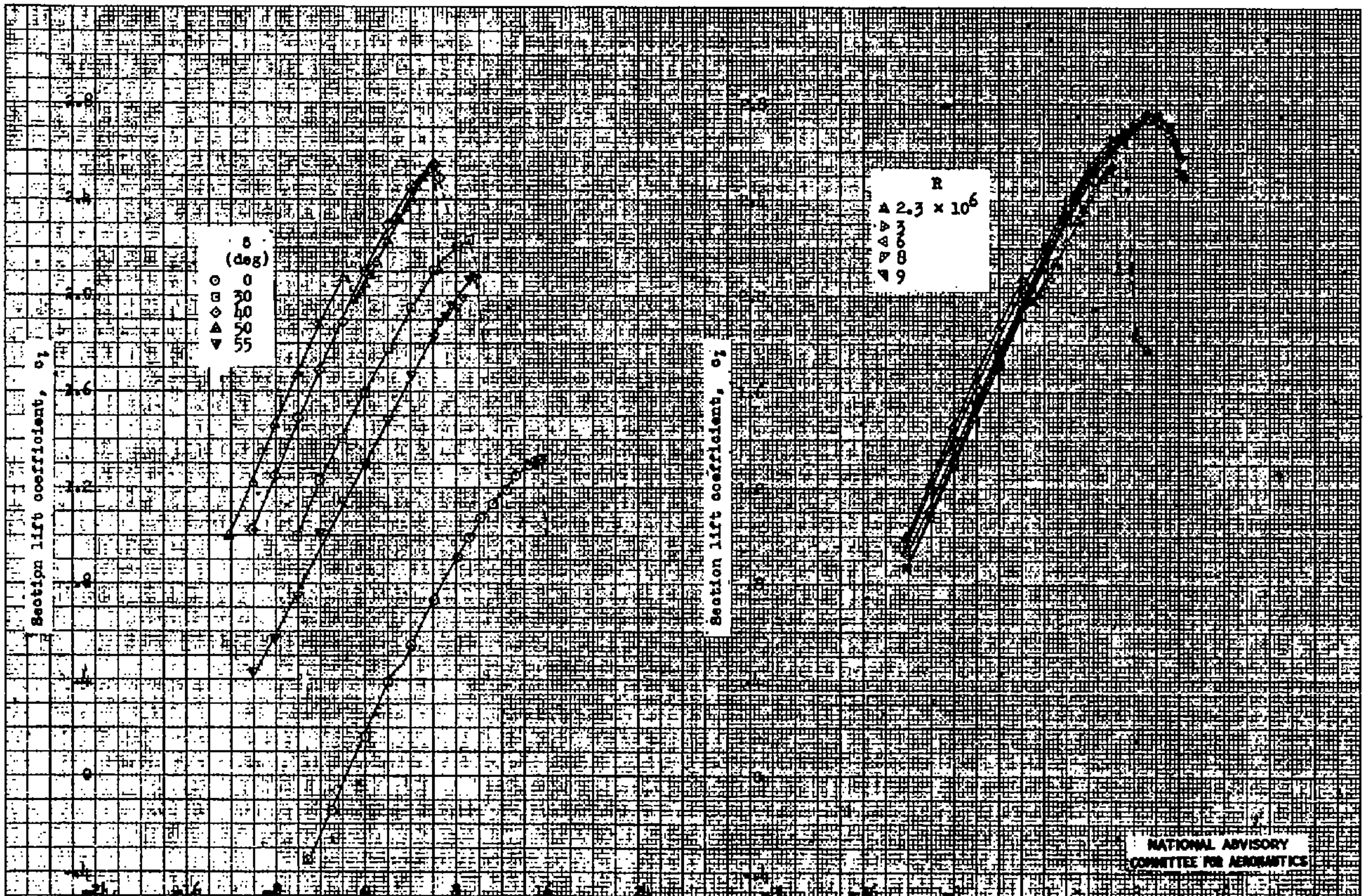
Figure 6.- Sketch of the double slotted flap.
Vane 1, configuration 1, pivot point A.



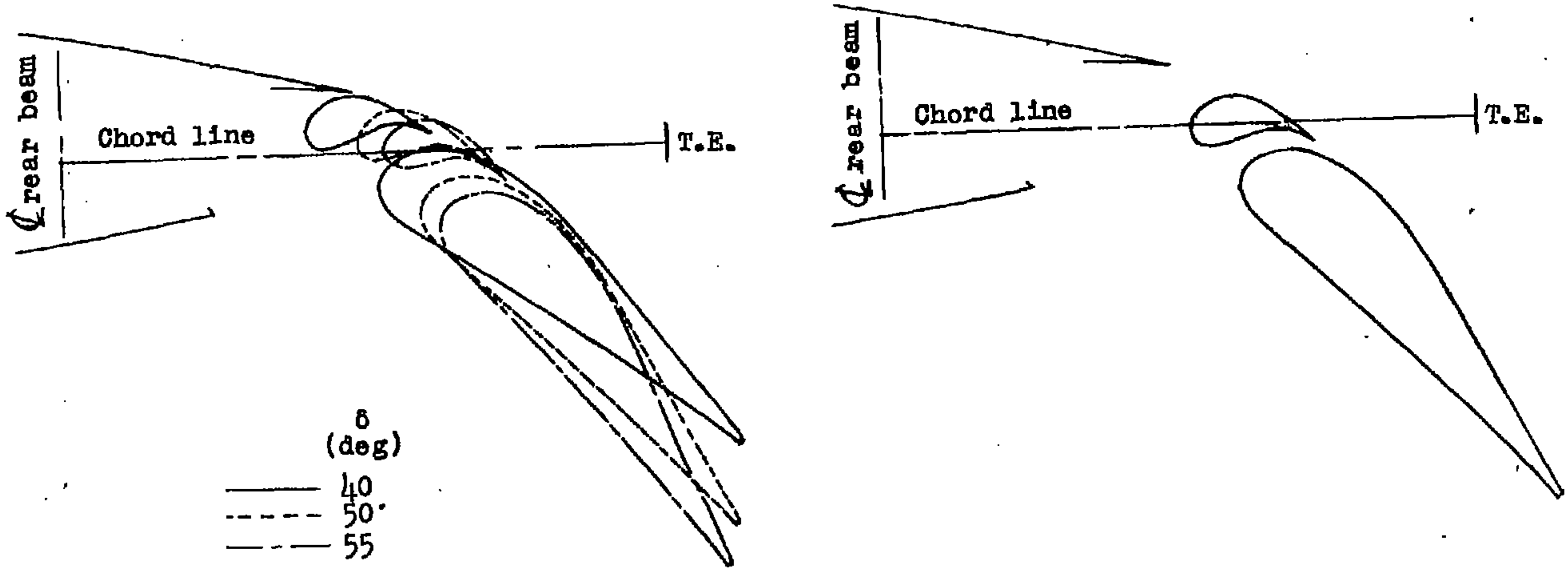
Section angle of attack, α_o, deg

(a) $R = 2.3 \times 10^6$.

Section angle of attack, α_o, deg

(b) $\delta = 50°$.

Figure 7.- Lift characteristics of an approximately 14-percent-thick NACA 66-series-type airfoil section equipped with a double slotted flap. Original ordinates; vane 1, configuration 1, pivot point A; tests, TDT 716 and LTT 359.



(a) Configuration 2, pivot point A.

(b) Configuration 1, deflection 50°, pivot point A.

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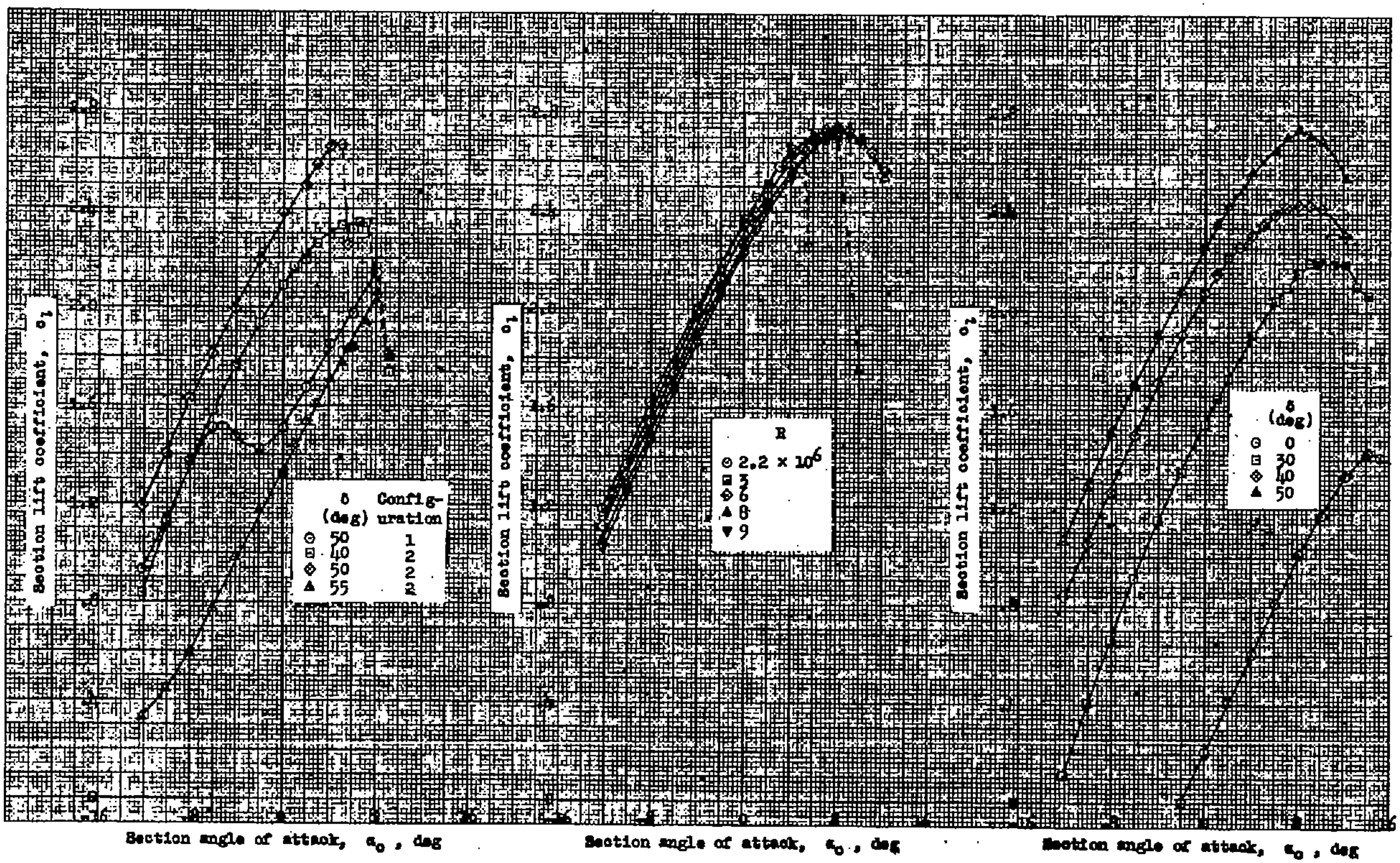
Figure 8.- Various arrangements of the double slotted flap tested with vane 3.



(a) Configurations 1 and 2; R = 2.2 × 10^6.

(b) Configuration 2; δ = 50°.

(c) Configuration 2; R = 8 × 10^6.

Figure 9.- Lift characteristics of an approximately 14-percent-thick NACA 66-series-type airfoil section equipped with a double slotted flap. Original ordinates; vane 3, pivot point A; test, TDT 712.

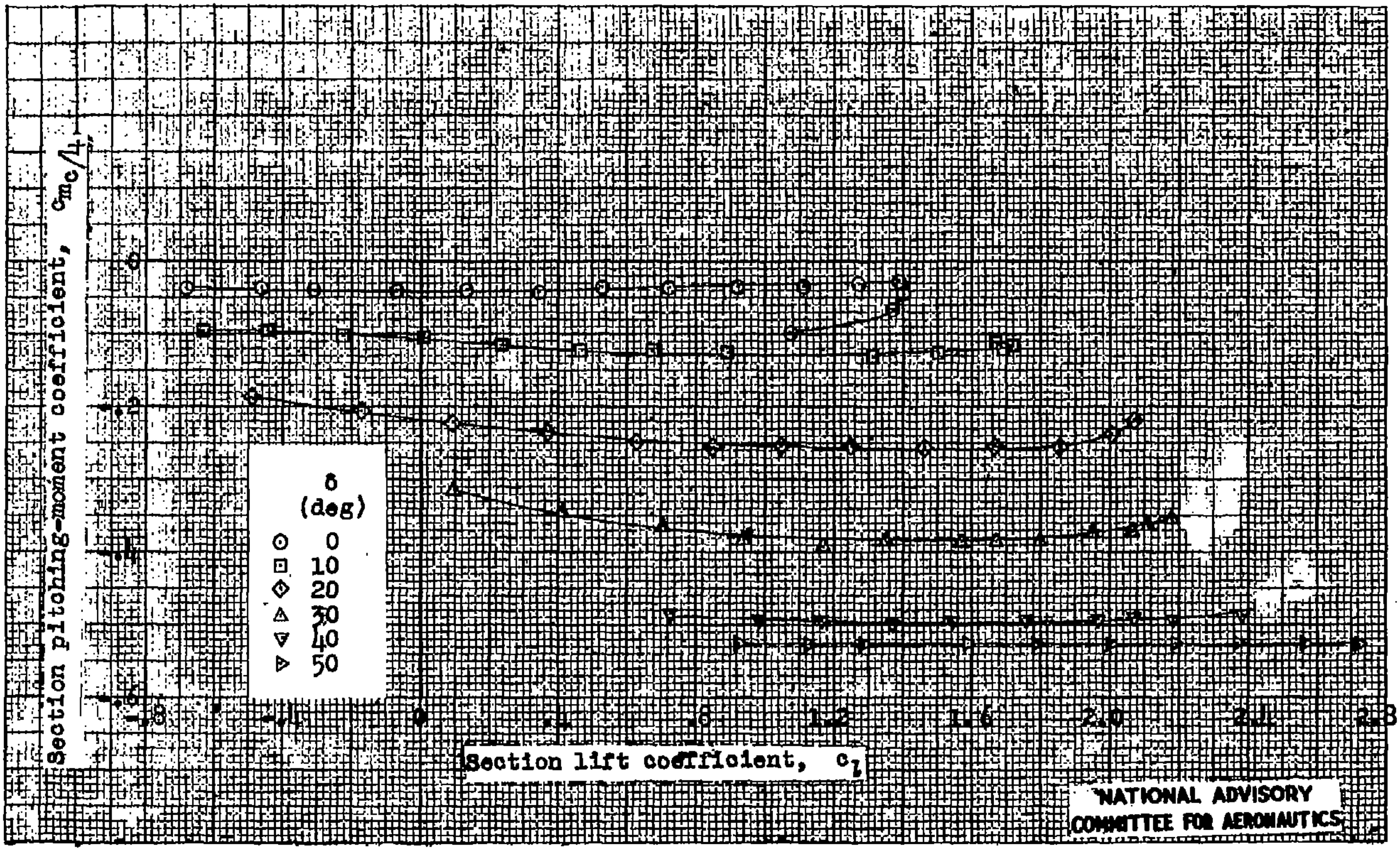
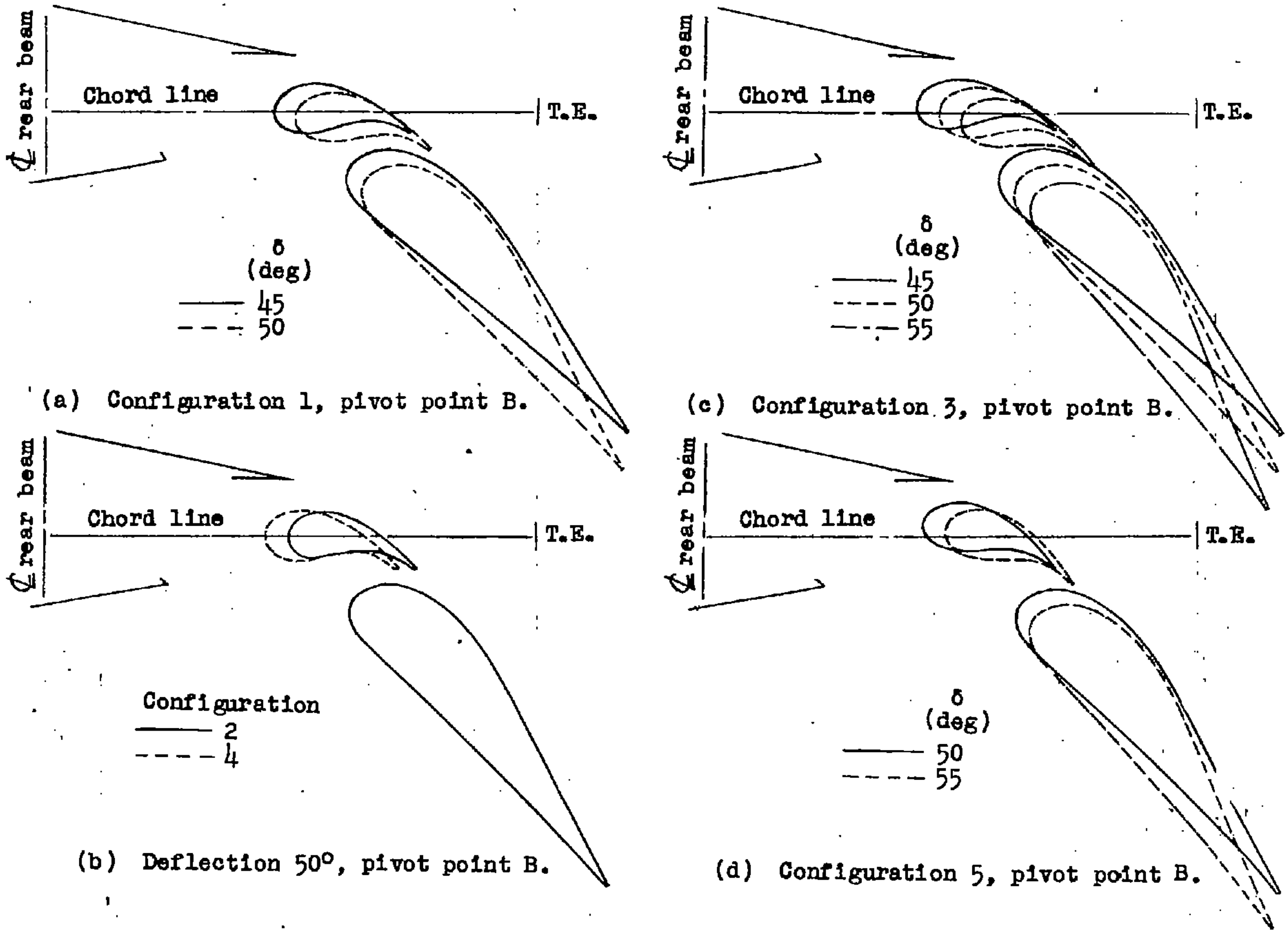


Figure 10.- Pitching-moment characteristics of an approximately 14-percent-thick NACA 66-series-type airfoil section equipped with a double slotted flap. Original ordinates; vane 3, configuration 2, pivot point A; $R = 8 \times 10^6$; tests, TDT 713 and 715.



(a) Configuration 1, pivot point B.

(b) Deflection 50°, pivot point B.

(c) Configuration 3, pivot point B.

(d) Configuration 5, pivot point B.

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Figure 11.- Various arrangements of the double slotted flap tested with vane 4.

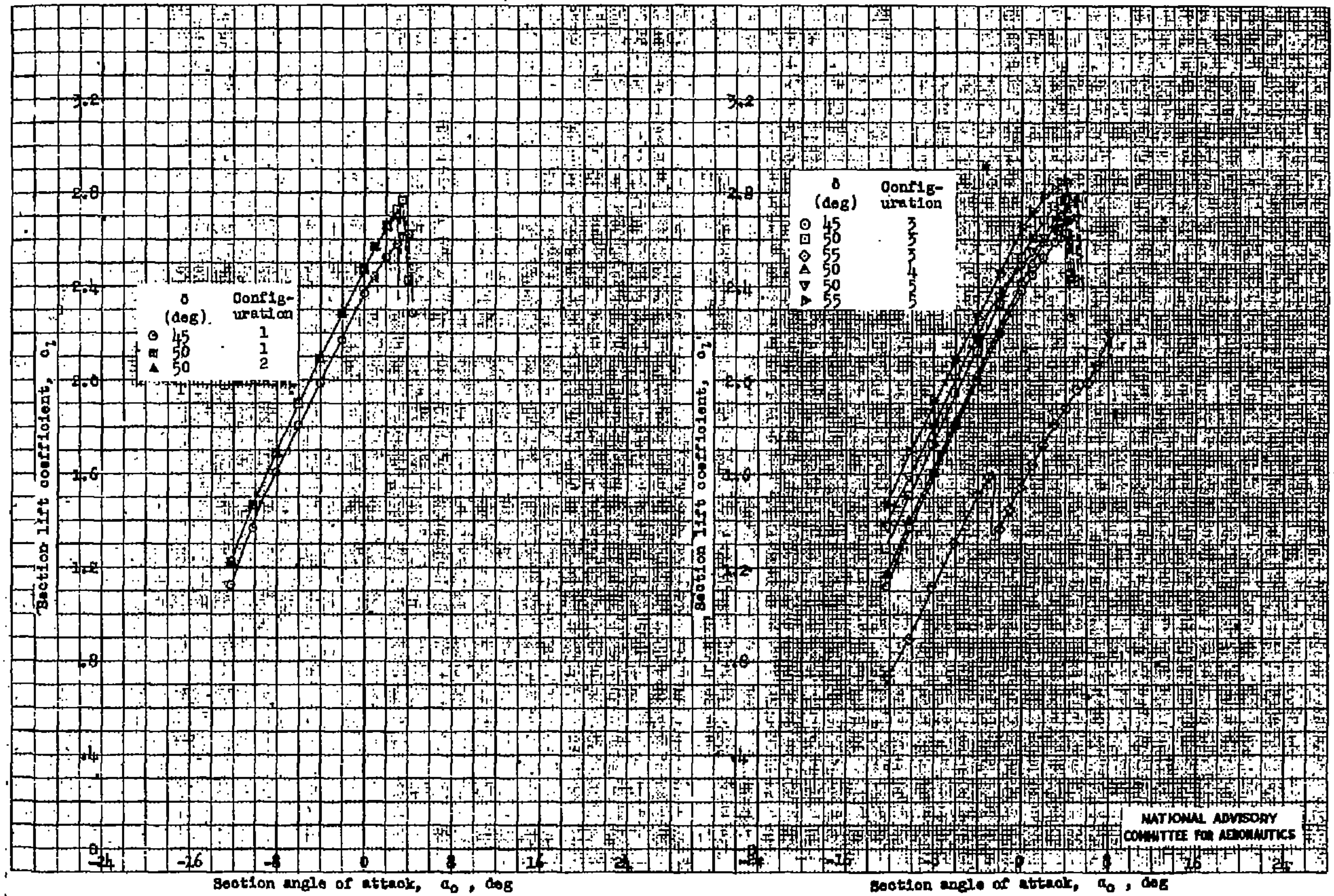
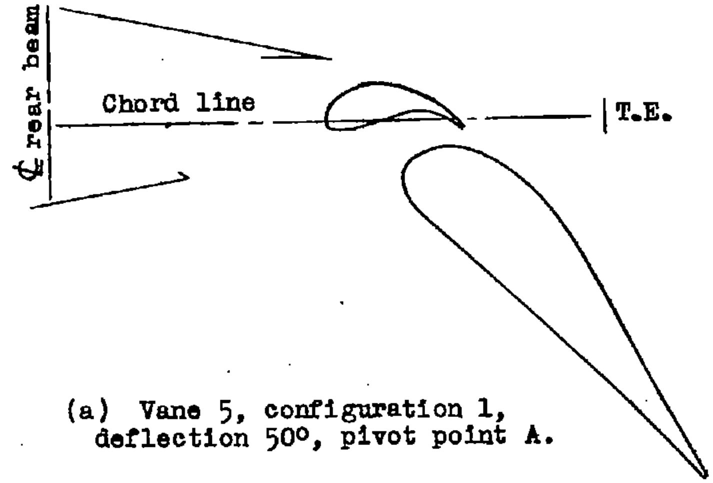


Figure 12.- Lift characteristics of an approximately 14-percent-thick NACA 66-series-type airfoil section equipped with a double slotted flap. Original ordinates; vane 4, pivot point B; $R = 2.3 \times 10^6$; tests, LTT 362 and 363.



(a) Vane 5, configuration 1, deflection 50°, pivot point A.

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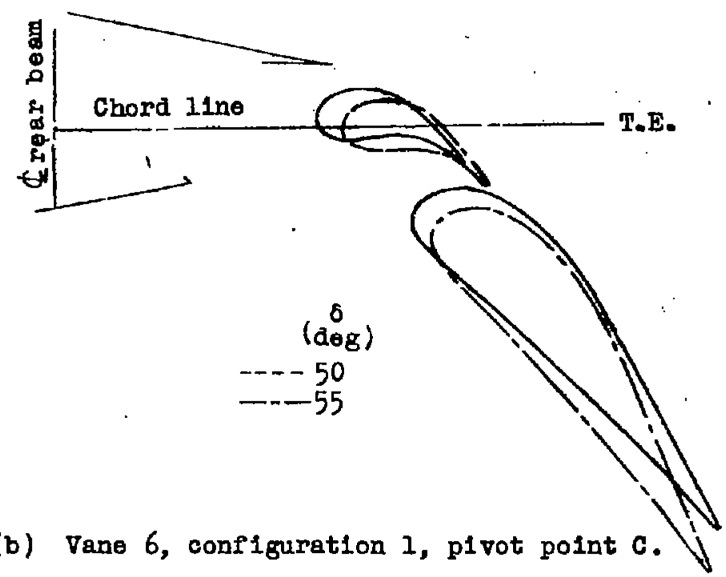
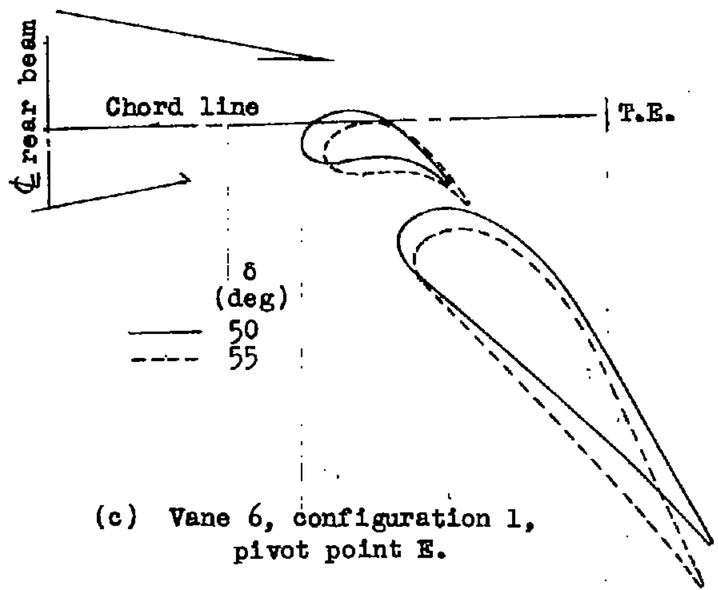
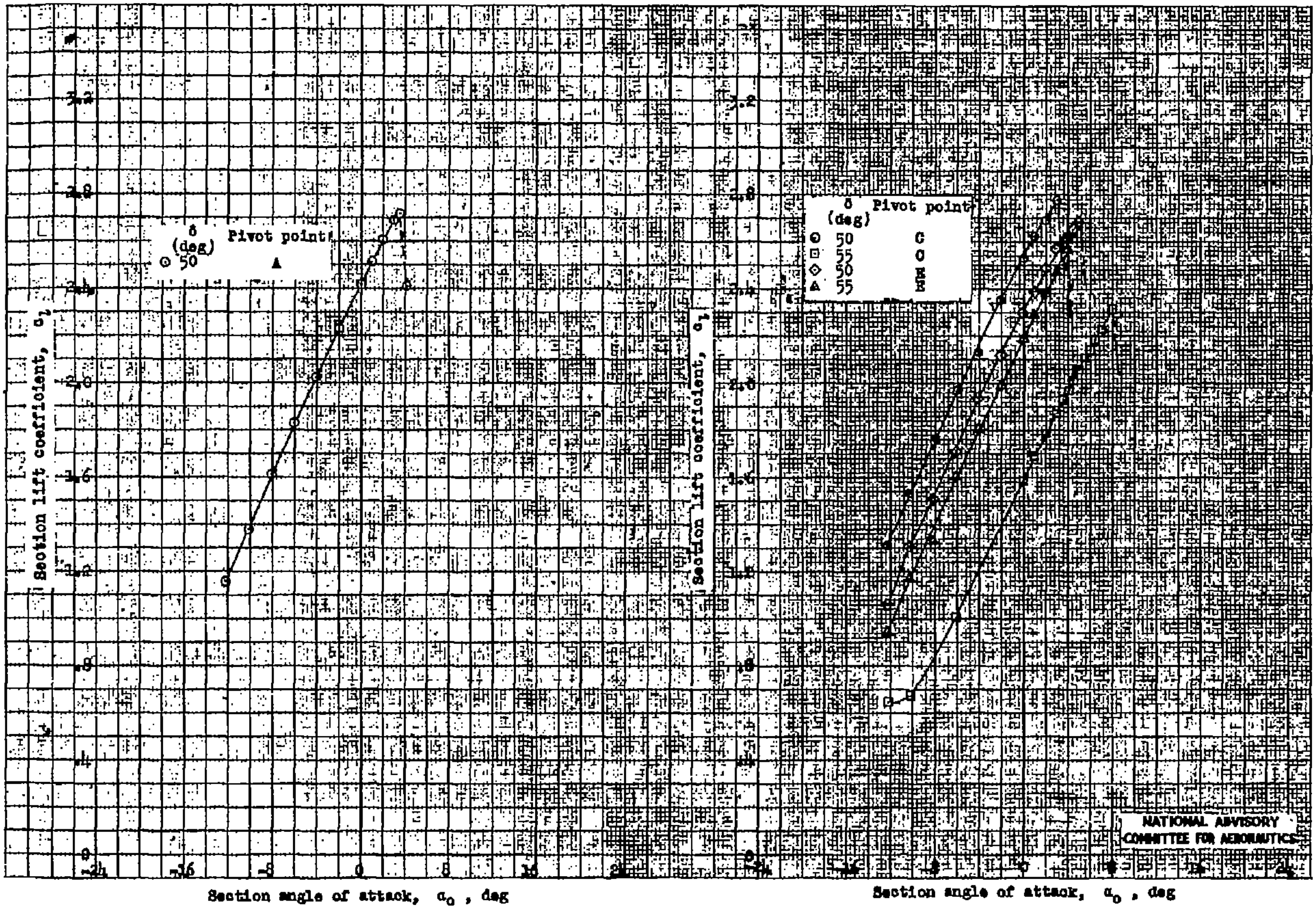


(b) Vane 6, configuration 1, pivot point C.



(c) Vane 6, configuration 1, pivot point E.

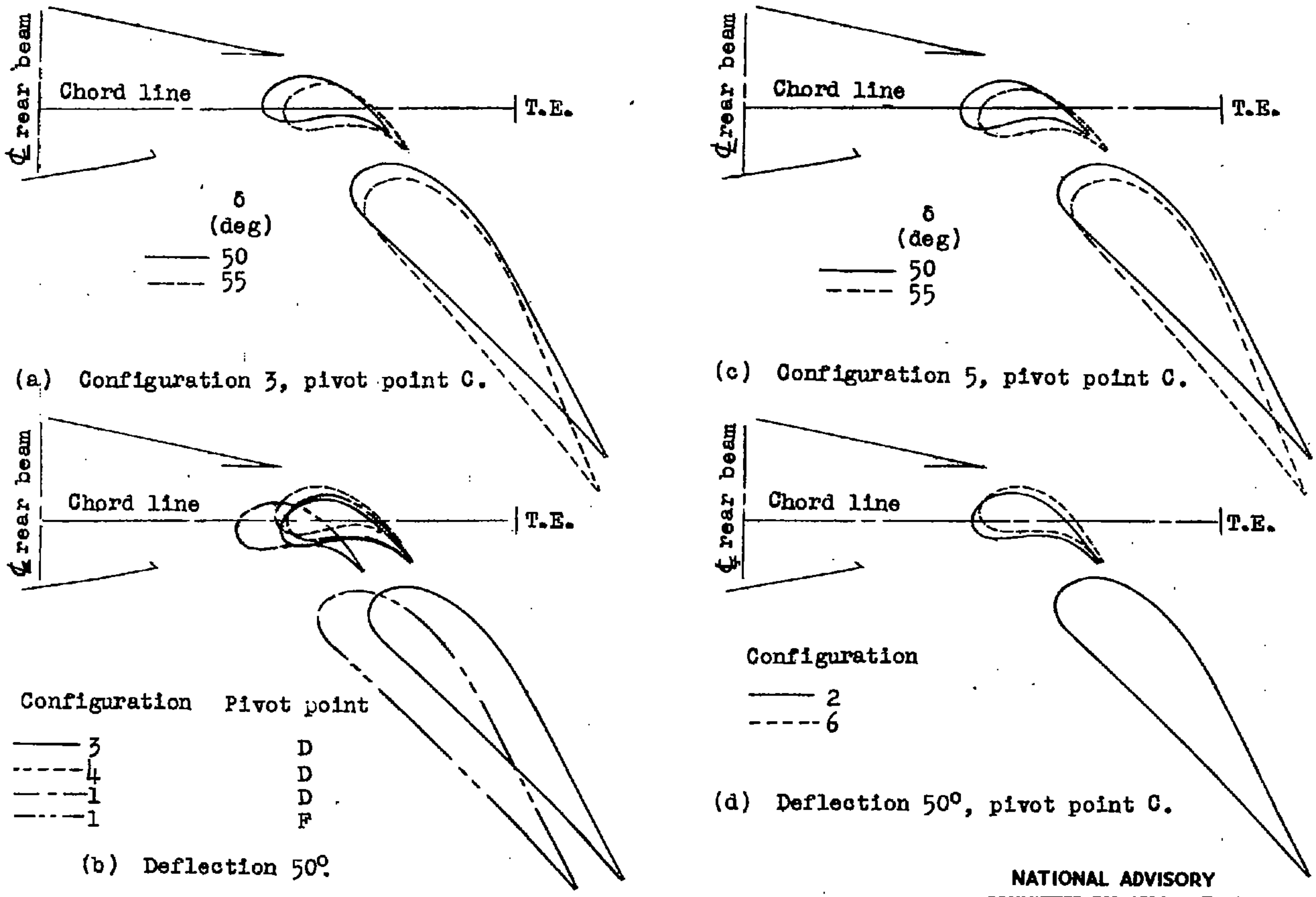
Figure 13.- Various arrangements of the double slotted flap tested with vanes 5 and 6.



(a) Vane 5, configuration 1.

(b) Vane 6, configuration 1

Figure 14.- Lift characteristics of an approximately 14-percent-thick NACA 66-series-type airfoil section equipped with a double slotted flap. Original ordinates; vanes 5 and 6; $R = 2.3 \times 10^6$; tests, LTT 363 and 366.



(a) Configuration 3, pivot point C.

(b) Deflection 50°.

(c) Configuration 5, pivot point C.

(d) Deflection 50°, pivot point C.

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Figure 15.- Various arrangements of the double slotted flap tested with vane 6.

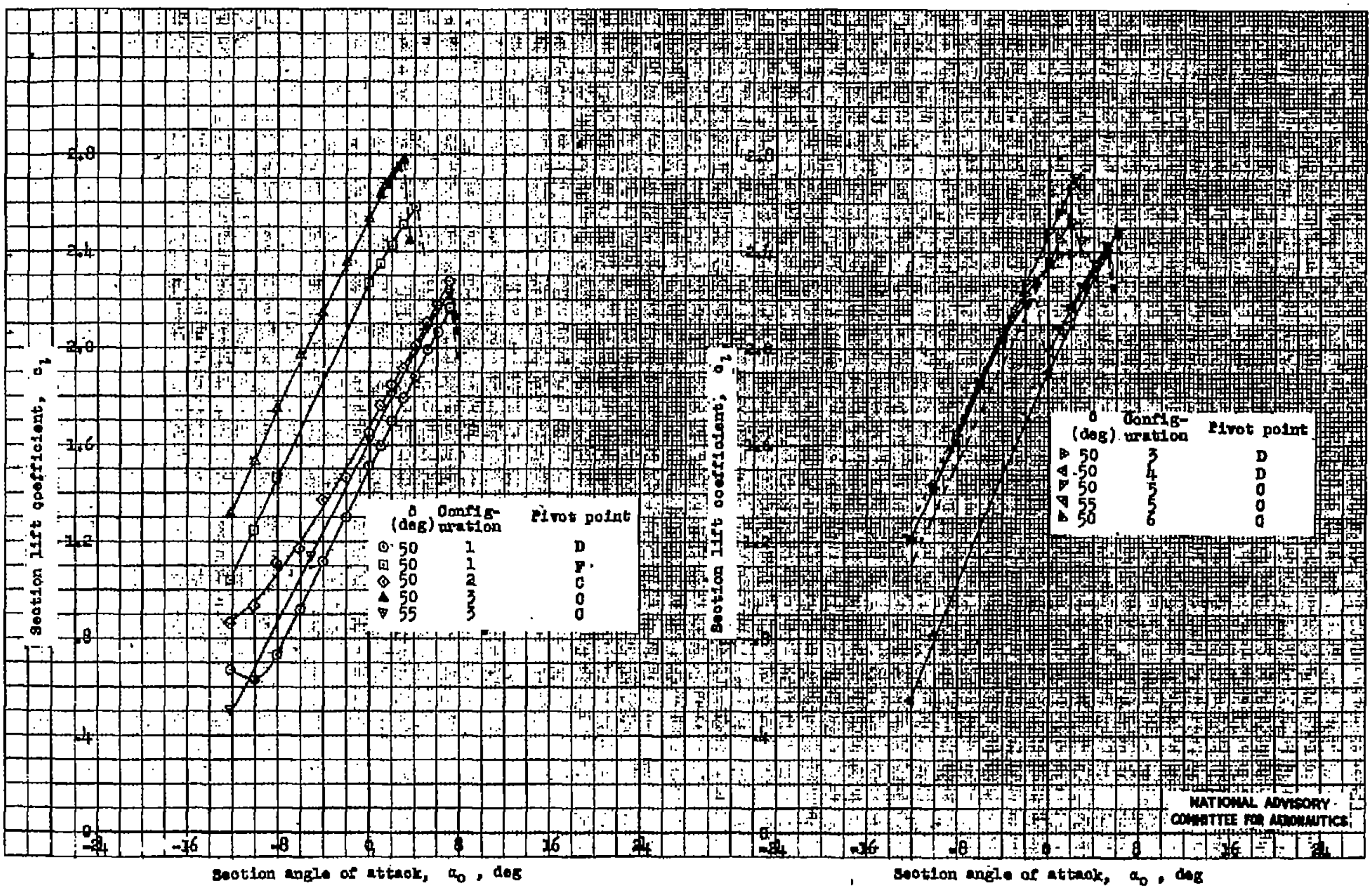
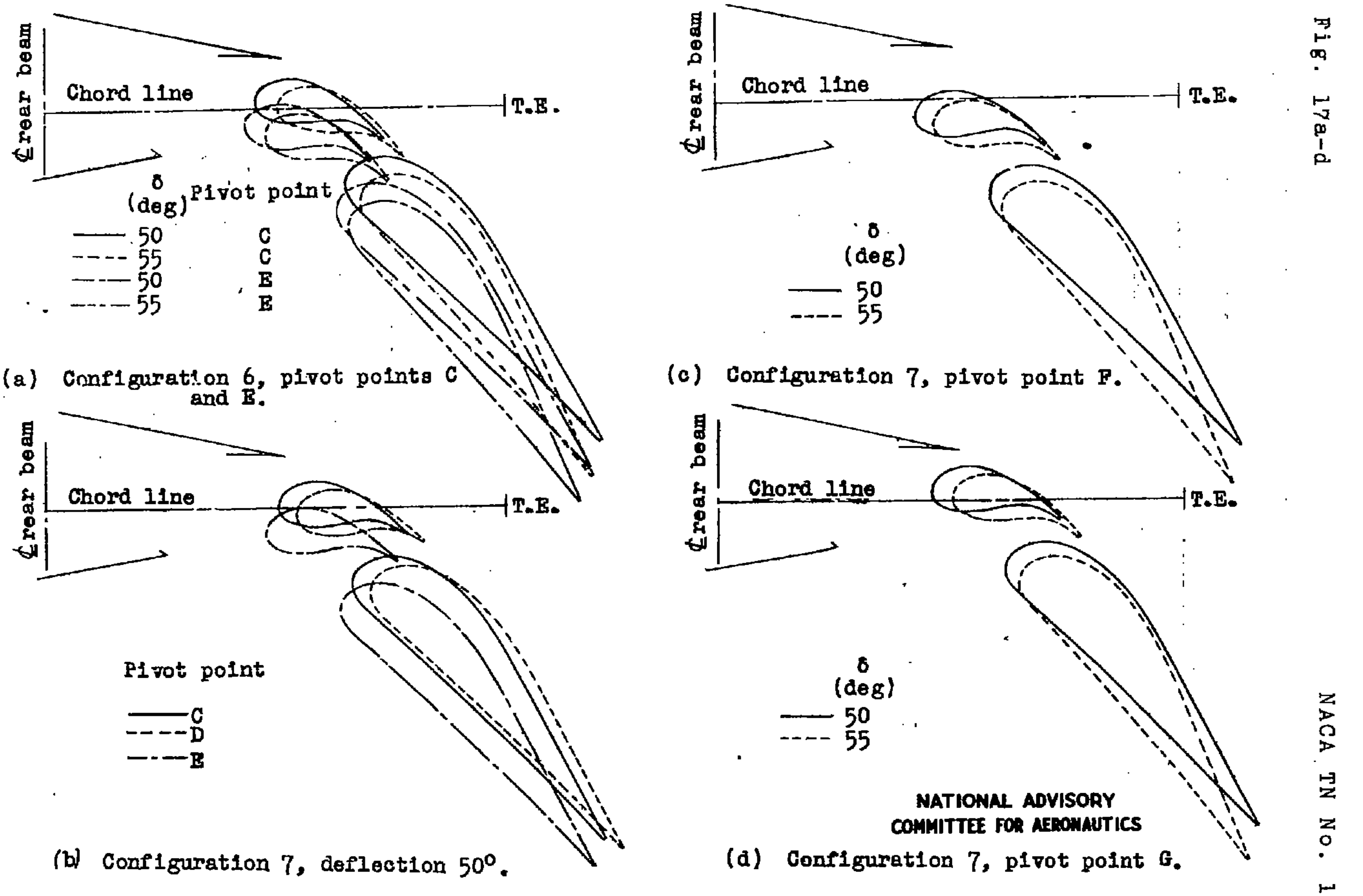


Figure 16.- Lift characteristics of an approximately 14-percent-thick NACA 66-series-type airfoil section equipped with a double slotted flap. Calculated ordinates; vane 6, $R = 2.3 \times 10^6$; test, LTT 370.



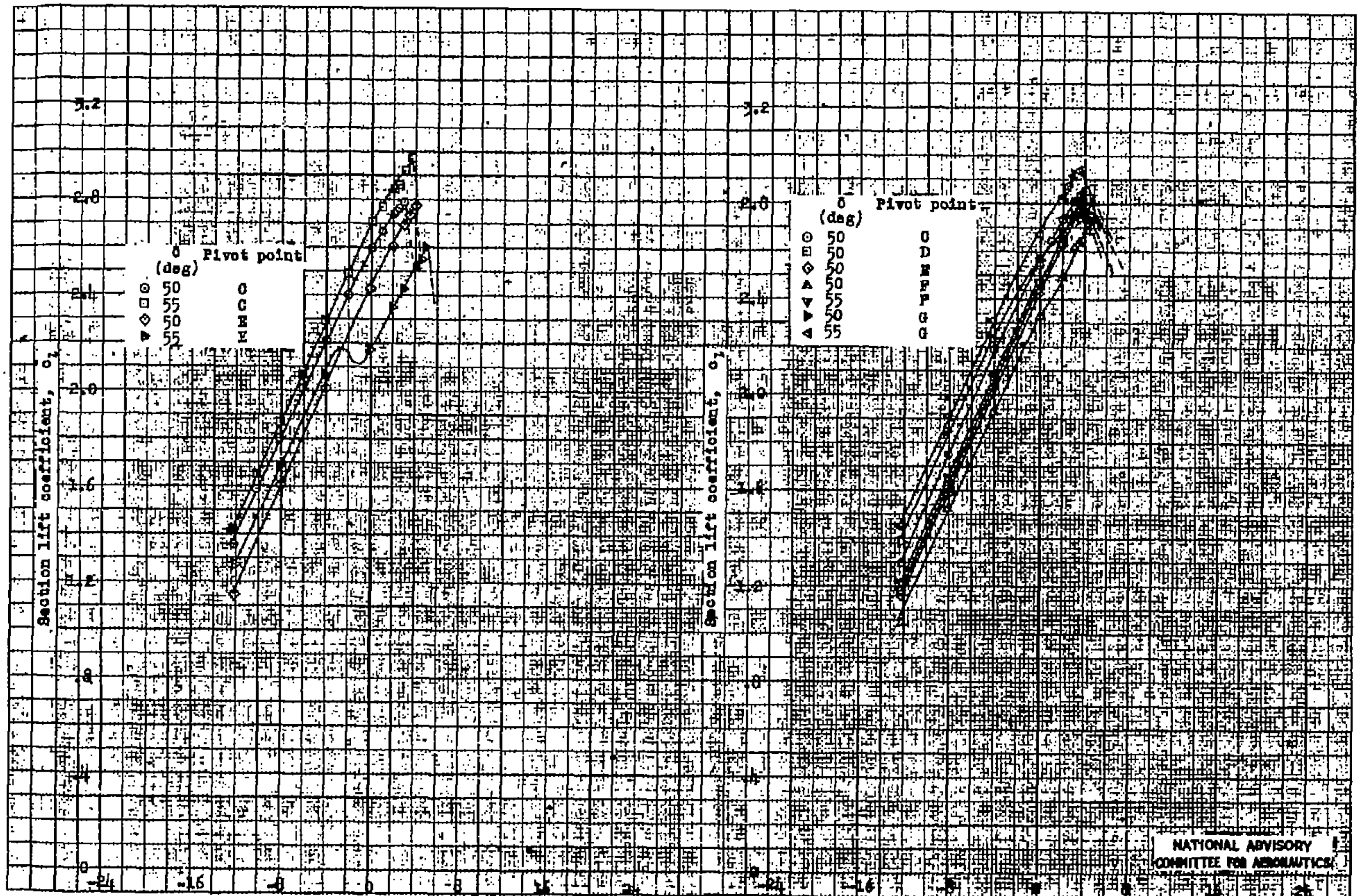
(a) Configuration 6, pivot points C and E.

(b) Configuration 7, deflection 50°.

(c) Configuration 7, pivot point F.

(d) Configuration 7, pivot point G.

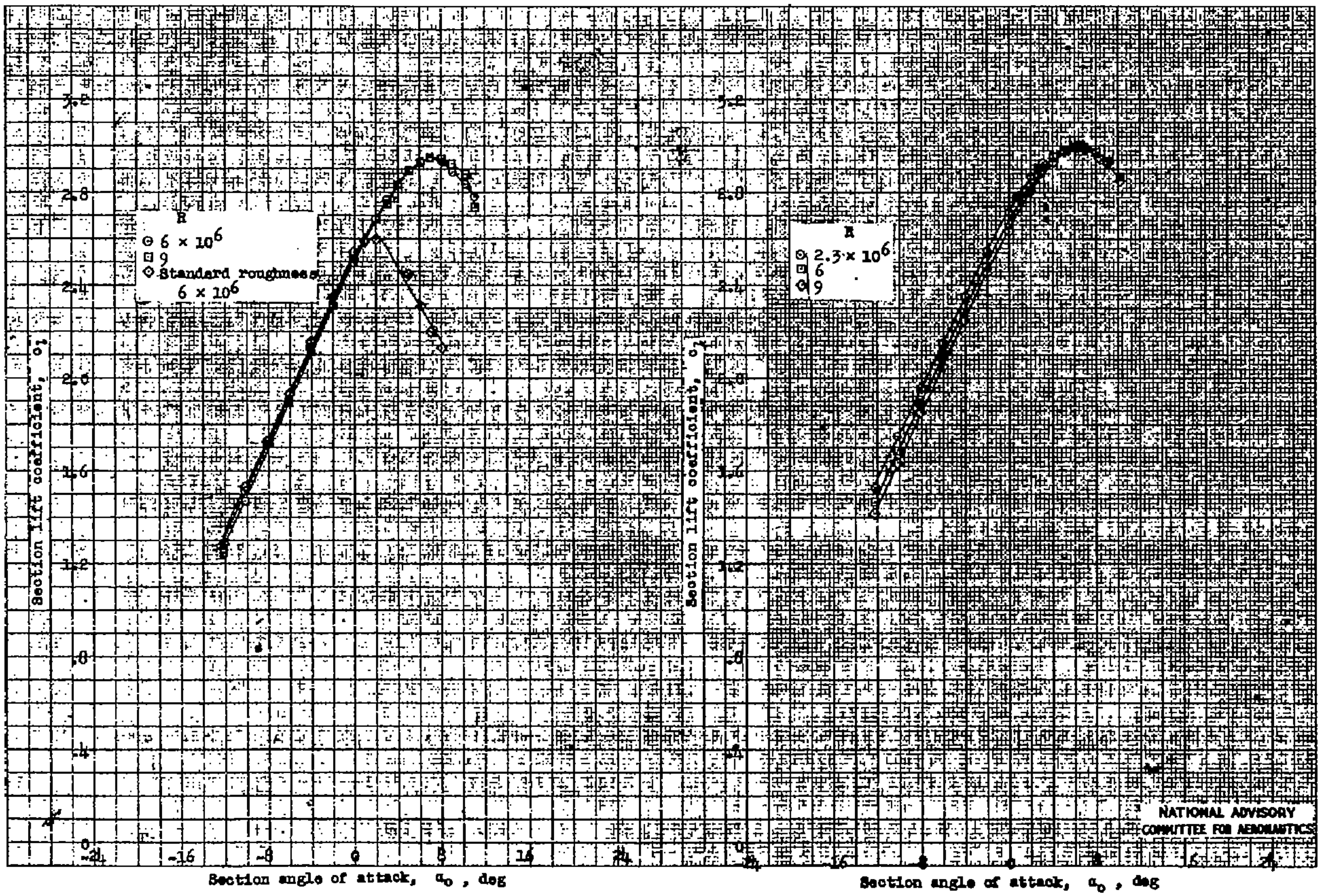
Figure 17.- Various arrangements of the double slotted flap tested with vane 4.



(a) Configuration 6, $R = 2.3 \times 10^6$.

(b) Configuration 7, $R = 2.3 \times 10^6$.

Figure 18.- Lift characteristics of an approximately 14-percent-thick NACA 66-series-type airfoil section equipped with a double slotted flap. Calculated ordinates; vane 4; tests, TDT 737, 740, and LTT 372.



(c) Configuration 7, pivot point C, $\delta = 50^{\circ}$.

(d) Configuration 7, pivot point B, $\delta = 55^{\circ}$.

Figure 18.- Concluded.

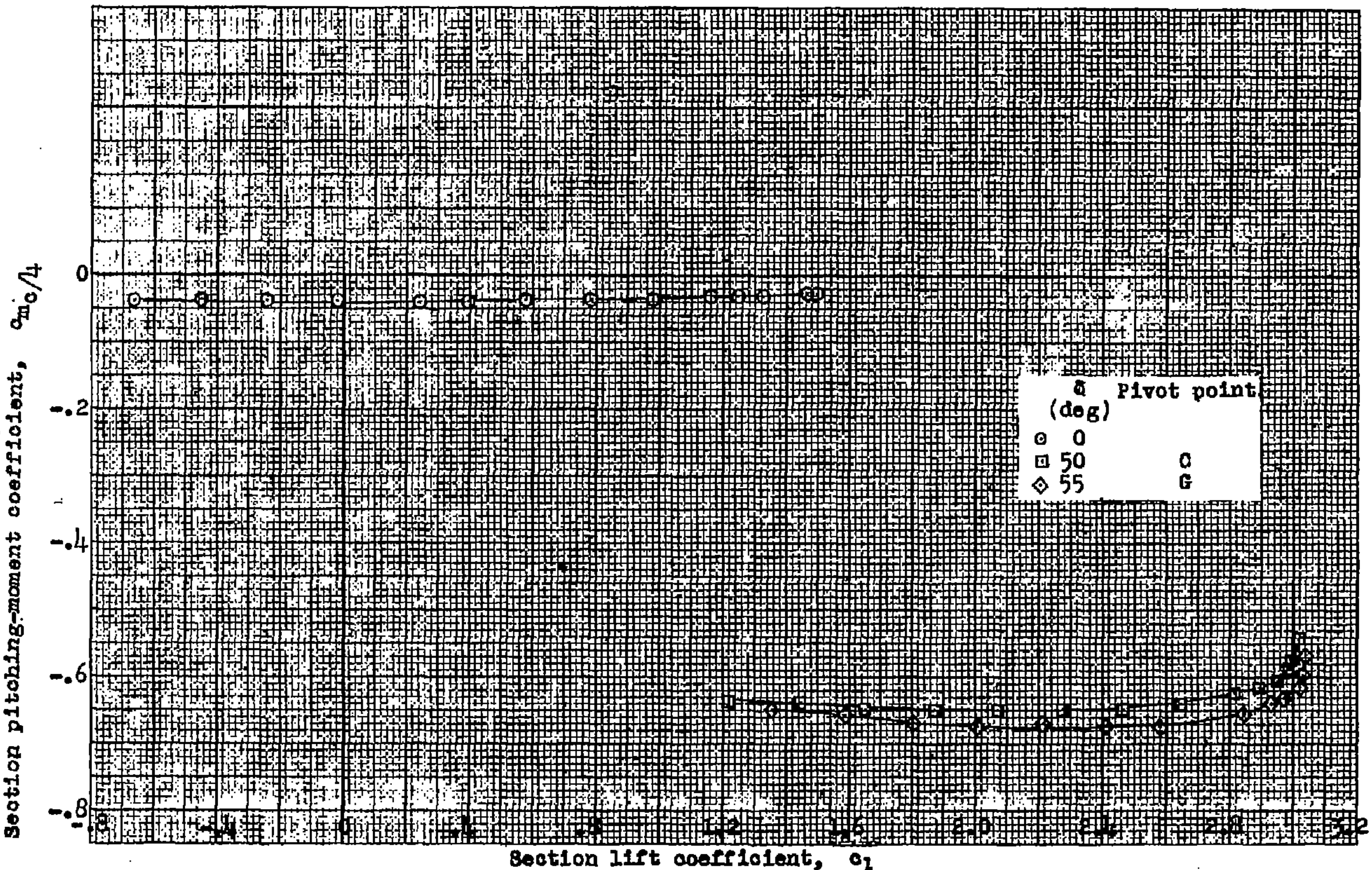


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Figure 19.- Pitching-moment characteristics of an approximately 14-percent-thick NACA 66-series-type airfoil section equipped with a double slotted flap. Calculated ordinates; vane 4, configuration 7; $R = 6 \times 10^6$; test, TDT 738.

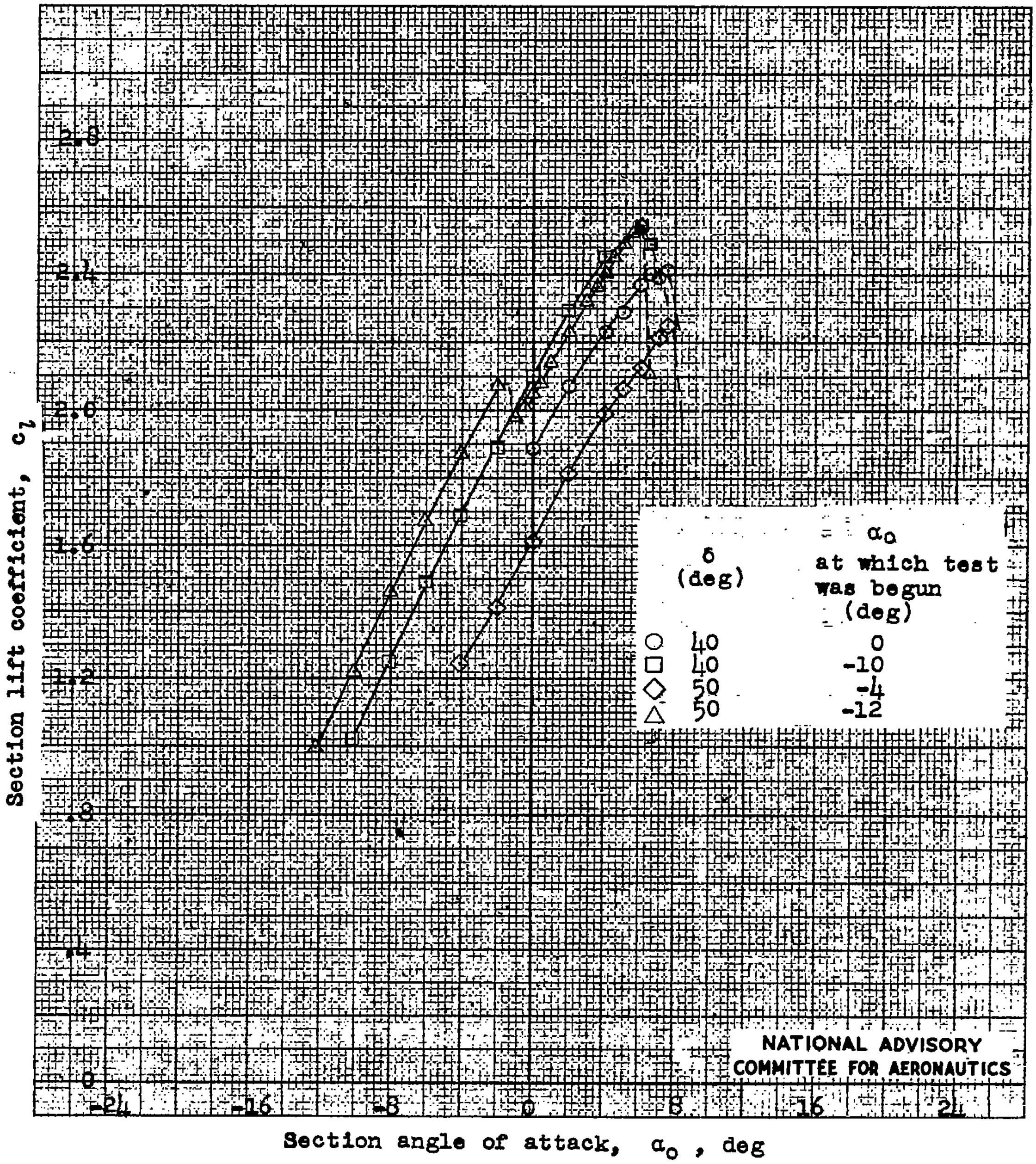

Figure 20.- Variation of c_l with α_o for an approximately 14-percent-thick NACA 66-series-type airfoil section equipped with a double slotted flap showing the effect of initial α_o on the lift characteristics. Original ordinates; vane 1, configuration 1, pivot point A; $R = 2.3 \times 10^6$; test, LTT 359.